

学校编码: 10384  
学号: 19920061151879

分类号\_\_\_\_密级\_\_\_\_  
UDC\_\_\_\_

厦 门 大 学

硕 士 学 位 论 文

可植入式微器件中若干技术的研究

Investigation of Some Technologies in Implantable  
Micro Devices

李伟红

指导教师姓名: 郭航 教授

专 业 名 称: 微电子学与固体电子学

论文提交日期: 2009 年 6 月

论文答辩时间: 2009 年 6 月

学位授予日期: 2009 年 6 月

答辩委员会主席: \_\_\_\_

评阅人: \_\_\_\_

2009 年 5 月

厦门大学博硕士论文摘要库

## 厦门大学学位论文原创性声明

兹提交的学位论文，是本人在导师指导下独立完成的研究成果。本人在论文写作中参考的其他个人或集体的研究成果，均在文中以明确方式标明。本人依法享有和承担由此论文产生的权利和责任。

声明人（签名）：

年 月 日

厦门大学博硕士论文摘要库

## 厦门大学学位论文著作权使用声明

本人完全了解厦门大学有关保留、使用学位论文的规定。

厦门大学有权保留并向国家主管部门或其指定机构送交论文的纸质版和电子版，有权将学位论文用于非赢利目的的少量复制并允许论文进入学校图书馆被查阅，有权将学位论文的内容编入有关数据库进行检索，有权将学位论文的标题和摘要汇编出版。保密的学位论文在解密后适用本规定。

本学位论文属于

1. 保密（ ），在      年解密后适用本授权书。
2. 不保密（ ）

（请在以上相应括号内打“√”）

作者签名：                      日期：      年      月      日

导师签名：                      日期：      年      月      日

厦门大学博硕士论文摘要库

## 摘要

随着 MEMS 技术的迅速发展,许多种微型器件被研究开发以用于生物医学领域。可植入式微器件是目前 MEMS 技术应用于医学领域的一个前沿课题。本文主要研究了可植入式器件中的若干问题,包括三个部分:

### 第一部分:一种用于可植入微型射频 MEMS 电感线圈的研究

首先分析了硅衬底上电感模型及影响其品质因数的各个因素,在此基础上研究玻璃衬底上的微型射频 MEMS 电感线圈,运用 HFSS 软件进行优化设计,确定了制作工艺,完成了器件的微制造并进行了测试。

### 第二部分:可植入式器件封装技术的研究

在对可植入式器件的要求、性质进行分析的基础上,研究了可植入式器件的封装技术。然后以微型射频 MEMS 电感线圈作为样品分别使用两种方法:金属封装法与复合  $\text{Si}_x\text{N}_y\text{-SiO}_2\text{-Si}_x\text{N}_y$  介质薄膜和有机硅胶连用的封装法对其进行封装,对封装好的样品在模拟人体环境的生理盐水中进行了测试。测试结果表明,使用复合介质薄膜和有机硅胶进行封装具有更好的性能,能使微器件在植入环境中长期工作。

### 第三部分:可植入式信号发射系统的初步研究

在分析了可植入式信号发射与接收系统的工作要求的基础上对其信号发射与接收电路进行了分析,接着研究了一种脉冲振荡器芯片,结果表明:这个脉冲振荡器芯片能够满足可植入式信号发射系统的要求。

**关键词:** 可植入式器件; MEMS ; 电感线圈 ; 封装技术

厦门大学博硕士论文摘要库



## Abstract

With the rapid development of MEMS technology during the past 20 years, many micro devices have been developed and used in the biomedical engineering. The implantable device is a cutting-edge topic which is a MEMS technology application used in the medical field. Several technical issues of the implantable device were studied in this paper which mainly includes three parts:

### Part I: Study of an implantable micro RF MEMS inductive coil

First, the inductance model on the silicon substrate and factors which impact the quality factor of the inductive coil were analyzed. Based on that, the micro RF MEMS inductive coil on the glass substrate was studied. The HFSS software was used to optimize the design of the coil and determine the production process. The microfabrication and test of the device were completed.

### Part II: Study of the packaging technology for implantable microdevices

Based on the analysis of the requirement and performance of the implantable device, the packaging technology was studied. Two packaging methods were developed by using the implantable micro RF MEMS inductive coil as the sample. The first method used metal to package and the second one used the  $\text{Si}_x\text{N}_y$ - $\text{SiO}_2$ - $\text{Si}_x\text{N}_y$  dielectric thin film and organic silicone simultaneously. And then the two packaged devices were tested by being put into the saline which was similar to the human body environment. The result shows that the device which was packaged by  $\text{Si}_x\text{N}_y$ - $\text{SiO}_2$ - $\text{Si}_x\text{N}_y$  dielectric thin films and organic silicone has better performance and longer working hours in implanted environment.

### Part III: Preliminary study of the signal emitting system for implantable microdevices

The circuits of the implantable signal emitting and receiving system were analyzed based on the working requirement analysis. And then an implantable pulse oscillator chip was studied. The result shows that the pulse oscillator implantable chip can meet the requirement of the implantable signal emitting system.

**Keywords:** Implantable devices; MEMS; Inductor coil; Package technology

厦门大学博士论文摘要库

---

# 目录

<b>第一章 绪论 .....</b>	<b>1</b>
1.1 可植入式器件简介 .....	1
1.2 可植入式器件研究中的关键技术问题 .....	4
1.2.1 集成电路与微电子机械系统技术 .....	4
1.2.2 通信技术 .....	5
1.2.3 电源技术 .....	5
1.2.4 封装技术 .....	7
1.2.5 植入技术 .....	8
1.2.6 电极和联结电缆技术 .....	8
1.3 可植入式器件研究技术中存在的问题 .....	8
1.4 论文内容及组织结构 .....	10
参考文献 .....	12
<b>第二章 一种应用于可植入式器件的微型射频 MEMS 电感线圈 .....</b>	<b>15</b>
2.1 硅基集成电感简介 .....	16
2.2 硅衬底微型射频 MEMS 电感线圈 .....	17
2.2.1 硅衬底微型射频 MEMS 电感线圈的主要电学参数 .....	17
2.2.2 提高硅衬底微型射频 MEMS 电感线圈品质因数的方法 .....	20
2.2.3 硅衬底微型射频 MEMS 电感线圈品质因数随参数的变化 .....	21
2.3 玻璃衬底微型射频 MEMS 电感线圈的设计与制作 .....	22
2.3.1 玻璃衬底微型射频 MEMS 电感线圈结构参数设计 .....	22

2.3.2 玻璃衬底上微型射频 MEMS 电感线圈的制作 .....	25
<b>2.4 本章小结 .....</b>	<b>27</b>
<b>参考文献 .....</b>	<b>28</b>
<b>第三章 可植入式器件封装技术的研究 .....</b>	<b>31</b>
<b>3.1 可植入式器件封装简介 .....</b>	<b>31</b>
3.1.1 生物相容性 .....	31
3.1.2 可植入式器件封装的意义 .....	32
3.1.3 可植入式器件的封装材料 .....	32
<b>3.2 可植入式器件封装技术的研究 .....</b>	<b>34</b>
3.2.1 可植入式封装材料的选择 .....	35
3.2.2 两种可植入式封装技术 .....	35
3.2.3 封装性能测试 .....	41
3.2.4 测试结果与分析 .....	45
<b>3.3 本章小结 .....</b>	<b>47</b>
<b>参考文献 .....</b>	<b>48</b>
<b>第四章 可植入式信号发射系统初步研究 .....</b>	<b>49</b>
<b>4.1 可植入式信号发射与接收系统的工作要求 .....</b>	<b>49</b>
<b>4.2 可植入式系统信号发射与接收电路的分析 .....</b>	<b>50</b>
<b>4.3 一种用于可植入式信号发射的脉冲振荡器芯片 .....</b>	<b>54</b>
4.3.1 电压基准产生电路 .....	55
4.3.2 电流镜电路 .....	56
4.3.3 低占空比的脉冲产生电路 .....	57

---

4.3.4 电感电容振荡器 .....	60
4.3.5 脉冲振荡器芯片的测试 .....	62
4.4 本章小结 .....	64
参考文献 .....	65
第五章 总结与展望 .....	67
5.1 论文工作总结 .....	67
5.2 论文工作的创新点和主要成果 .....	67
5.3 展望 .....	68

厦门大学博硕士论文摘要库

# Content

<b>Chapter I: Introduction.....</b>	<b>1</b>
<b>1.1 Introduction of implantable device.....</b>	<b>1</b>
<b>1.2 The Key technology of implantable devices research .....</b>	<b>4</b>
1.2.1 IC and MEMS.....	4
1.2.2 Communication technology .....	5
1.2.3 Power supply technology .....	5
1.2.4 Packageing technology .....	7
1.2.5 Embedding technology .....	8
1.2.6 Electrode and wire technology .....	8
<b>1.3 Problems in the study of implantable device research technology .....</b>	<b>8</b>
<b>1.4 Content and structure.....</b>	<b>10</b>
<b>reference .....</b>	<b>12</b>
<b>Chapter II: A micro RF MEMS inductive coil used in implantable devices.....</b>	<b>15</b>
<b>2.1 Introduction of silicon integrated inductor .....</b>	<b>16</b>
<b>2.2 Micro RF MEMS inductive coil with silicon substrate.....</b>	<b>17</b>
2.2.1 main electrics parameter of Micro RF MEMS inductive coil with silicon substrate.....	17
2.2.2 methods to improve the quality factor of Micro RF MEMS inductive coil with silicon substrate.....	20
2.2.3 the quality factor variety with the of Micro RF MEMS inductive coil with silicon substrate parameter.....	21
<b>2.3 Design and production of micro RF MEMS inductive coil with glass substrate.....</b>	<b>22</b>
2.3.1 Structure parameter design.....	22
2.3.2 Production .....	25
<b>2.4 Summary.....</b>	<b>27</b>
<b>reference .....</b>	<b>28</b>
<b>Chapter III:Research of implantable devices packaging technology ....</b>	<b>31</b>
<b>3.1 Introduction of Implantable devices packaging.....</b>	<b>31</b>
3.1.1 Biocompatibility .....	31

3.1.2 Significance of Implantable devices packaging.....	32
3.1.3 Material of Implantable device .....	32
<b>3.2 Research of implantable devices packaging technology .....</b>	<b>34</b>
3.2. Material selection of Implantable devices .....	35
3.2.2 Two methods of implantable devices packaging technology.....	35
3.2.3 Packaging Performance Test .....	41
3.2.4 Result and analysis.....	45
<b>3.3 Summary.....</b>	<b>47</b>
<b>reference .....</b>	<b>48</b>
<b>Chapter IV: Implantable signal emitting system.....</b>	<b>49</b>
<b>4.1 Requirements of the implantable signal emitting and receiving systems .....</b>	<b>49</b>
<b>4.2 Circuit analysis of the implantable signal emitting and receiving systems.....</b>	<b>50</b>
<b>4.3 An implantable pulse oscillator chip used in the implantable signal emitting system .....</b>	<b>54</b>
4.3.1 Circuit of voltage reference circuit .....	55
4.3.2 Current mirror circuit .....	56
4.3.3 Pulse generator circuit with low duty cycle .....	57
4.3.4 Inductive capacitor oscillator .....	60
4.3.5 Test of pulse oscillator chip .....	62
<b>4.4 Summary.....</b>	<b>64</b>
<b>reference .....</b>	<b>65</b>
<b>Chapter V: Conclusion and prospect .....</b>	<b>67</b>
<b>5.1 Main research content .....</b>	<b>67</b>
<b>5.2 Innovation and main results .....</b>	<b>67</b>
<b>5.3 Prospect.....</b>	<b>68</b>



Degree papers are in the "[Xiamen University Electronic Theses and Dissertations Database](#)". Full texts are available in the following ways:

1. If your library is a CALIS member libraries, please log on <http://etd.calis.edu.cn/> and submit requests online, or consult the interlibrary loan department in your library.
2. For users of non-CALIS member libraries, please mail to [etd@xmu.edu.cn](mailto:etd@xmu.edu.cn) for delivery details.

厦门大学博硕士论文摘要库